

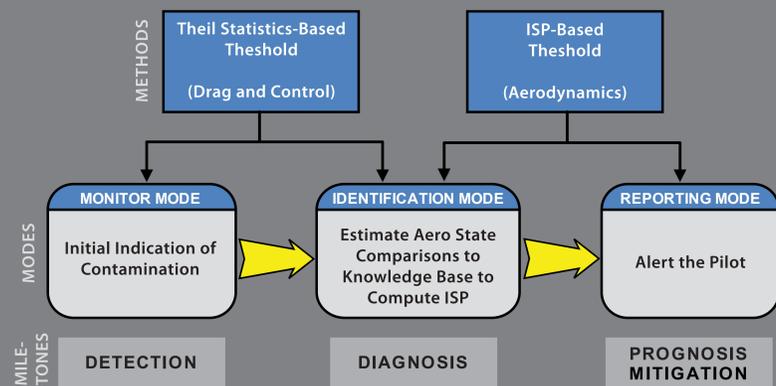


Real-time Methods to Reduce In-flight Icing Hazards

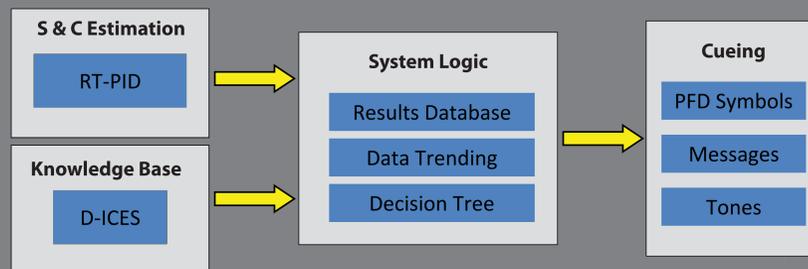
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ICEPro

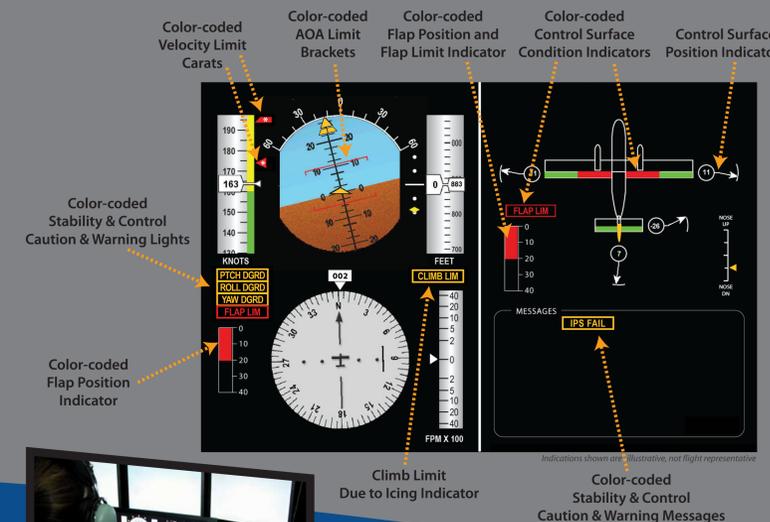
System Logic & Milestones Achieved



System Architecture



IVHM & ICEPro Displays



DETECTION

DIAGNOSIS

PROGNOSIS

MITIGATION

Research Goals

The research goals of this project included (1) development of an onboard system for assessing icing effects on aircraft state and the management / mitigation of a hazardous icing encounter, and (2) testing and evaluation of the proposed system in a simulation and/or experimental environment.

Expected Outcomes

The application of the technologies developed under this research are expected to prevent upsets & loss of control due to icing by performing a real-time assessment of aircraft stability, control & performance and providing the flight deck with safe envelope limit cues.

These technologies are also expected to improve tactical decision-making through performance-related, and S&C-related status messaging as well as safe speeds and configuration alerts.

System Architecture

The system architecture merges two methods to determine icing degradation and aircraft state: (1) a "knowledge-based" method consisting of a Dynamic Inversion Evaluation System (D-ICES) which predicts "normal" control usage given current vehicle state, and (2) a "real-time parameter identification" (RTPID) method consisting of a state estimator based on control response and programmed flight control stimulation.

The data from these two methods is fed into the logic system which determines the appropriate flight deck cues to display to the pilot including envelope and configuration limits as well as cautions and warnings messages.

Testing & Evaluation

An evaluation was conducted using 29 pilot subjects from Embry Riddle Aeronautical University (ERAU). The control group (14) flew tasks with basic displays whereas the experimental group (15) flew tasks with the ICEPro system.

The ICEPro group showed (1) fewer incipient upsets (statistically significant), (2) better situation awareness in many areas (statistically significant), and (3) no increase in workload with ICEPro.

Results & Recommendations

The results of the research indicated that ICEPro will mitigate a hazardous icing encounter and that ICEPro should improve system performance when coupled with flight guidance cues.

Recommendations include (1) conducting a flight test validation effort, and (2) assessing application to other flight hazards such as structural damage, control system problems, wind shear, and other non-icing related aero surface contamination.